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Maritimes Region

Proceedings of the Regional Framework Meeting for Use of Research Vessel Survey Data to Assess Secondary Groundfish Stocks in the Maritimes Region

December 16-17, 2014
Dartmouth, Nova Scotia

Chairperson and editor: Kristian Curran

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Fisheries and Oceans Canada
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July 2015

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

A "Proxy Approach" for estimating reference points for secondary stocks was proposed: the geometric mean of the stratified total biomass from the RV Survey (summer or winter, dependent on the stock) as a proxy for biomass at Maximum Sustainable Yield (B_{MSY}) for a chosen time period. Biological reference points were subsequently calculated where 40% of the proxy B_{MSY} was proposed as the Lower Reference Point and 80% of the proxy B_{MSY} was proposed as the Upper Stock Reference. The three-year running median of the biomass was then used to examine the long term trend in biomass against the reference points. Meeting participants discussed applicability of this approach for all secondary species, as it does not take into account the nuance of biomass history (e.g. fishing pressure). It was concluded that for some stocks the biomass history, as well as additional analytics to evaluate uncertainty, is needed to characterize proposed reference points. Guidance for evaluating uncertainty includes: 1) evaluate whether survey indices reflect fishery impact on the stock; 2) evaluate the impact of choice of period in the time series; and 3) evaluate additional information to inform the impact of the Proxy Approach. Given that many secondary stocks assessed at the meeting required further analysis, it was agreed that a Science Advisory Report would not be completed and published as part of the meeting's products. Last, it was agreed by some meeting participants that despite limitations in the proposed Proxy Approach, it remains very important to derive reference points for many of the secondary stocks in question, as there are some urgent management needs for many of the species that were discussed (especially for skates). Additional research in this regard was encouraged by all meeting participants.

Compte rendu de la réunion régionale sur le cadre d'utilisation des données des relevés par navire de recherche pour évaluer les stocks secondaires de poisson de fond dans la région des Maritimes

SOMMAIRE

Afin d'estimer les points de référence pour les stocks secondaires, on propose d'adopter une « approche axée sur des valeurs approximatives », qui consiste à utiliser la moyenne géométrique de la biomasse totale stratifiée tirée du relevé par navire de recherche (estival ou hivernal selon le stock) comme valeur approximative de la biomasse au rendement maximal soutenu (B_{RMS}) pour une période choisie. Par la suite, les points de référence biologiques sont calculés avec un point de référence limite proposé s'élevant à 40 % de l'indicateur de B_{RMS} et un point de référence supérieur proposé s'élevant à 80 % de l'indicateur de B_{RMS}. La médiane mobile de la biomasse sur trois ans est ensuite utilisée pour examiner les tendances à long terme de la biomasse par rapport aux points de référence. Les participants à la réunion discutent de l'applicabilité de cette approche à toutes les espèces secondaires, car elle ne tient pas compte de la nuance de l'historique de la biomasse (p. ex. pression exercée par la pêche). On conclut que, pour certains stocks, il faut tenir compte de l'historique de la biomasse, ainsi que des analyses supplémentaires à l'appui de l'évaluation des incertitudes, pour caractériser les points de référence proposés. Les directives pour l'évaluation des incertitudes sont les suivantes : 1) évaluer si les indices tirés des relevés témoignent des répercussions de la pêche sur le stock; 2) évaluer l'incidence du choix de la période de la série chronologique; 3) évaluer des renseignements supplémentaires pour clarifier l'effet de l'approche axée sur des valeurs approximatives. Étant donné que de nombreux stocks secondaires évalués au cours de la réunion exigent une analyse plus approfondie, il est convenu qu'un avis scientifique ne serait pas rédigé ni publié comme résultat de la réunion. Enfin, certains participants à la réunion conviennent que, malgré les limites de l'approche proposée quant à l'utilisation de valeurs approximatives, il est toujours très important d'établir des points de référence pour bon nombre des stocks secondaires en question, car de nombreuses espèces ayant fait l'objet des discussions (surtout les raies) ont certains besoins urgents en matière de gestion. Tous les participants à la réunion souhaitent que d'autres recherches soient réalisées à cet égard.

INTRODUCTION

Fisheries and Oceans Canada's (DFO) Precautionary Approach (PA) framework aims to be guided by units that relate directly to fish stock productivity. As such, the PA framework suggests priority be given to monitoring a stock and establishing data time series that allow for the identification of biological reference points. For reporting against the PA framework, fishery management plans strive to include harvest strategies that incorporate a Limit Reference Point (LRP) and an Upper Stock Reference (USR) (DFO 2006). The LRP and USR define the boundaries of the critical, cautious, and healthy stock status zones for a fish stock; the LRP is the divide between the cautious and critical zones and the USR the divide between the healthy and cautious zones. Ideally, all fish stocks incorporate reference points into their management; however, secondary fish stocks generally are not managed on this basis. To differentiate between Primary and Secondary stock categories in the DFO Maritimes Region (DFO Maritimes), a protocol entitled *Priority Setting Protocol for Fishery Assessment and Management: Primary and Secondary Stocks in the Maritimes Region* was presented at the 'DFO Maritimes Region Industry Roundtable'.

The overall objective of the priority setting protocol is to better align fishery management strategies with underlying science needs. Fish stocks that typically fall into the secondary stock category include groundfish stocks being caught by groundfish fisheries or caught as bycatch in other fisheries where the value and volume of their landings are relatively small (or where the stock has not otherwise been identified as a priority by the DFO Maritimes Region). In support of fish stock monitoring, DFO Maritimes has conducted an annual summer RV survey since 1970 in the Northwest Atlantic Fisheries Organization (NAFO) divisions 4VWX and the Canadian portion of 5Yb, as well as an annual winter RV survey since 1987 in NAFO Area 5Z (Georges Bank). Results from these surveys provide information for many groundfish species in the region. The DFO Maritimes summer and winter RV surveys provide data on biomass and abundance indices for groundfish stocks that span 45 years and 27 years, respectively. At an "*Advisory process for the development of reference points consistent with the precautionary approach for a variety of stocks in the Maritimes Region*" it was proposed that the RV survey biomass index could be used as a biomass at Maximum Sustainable Yield (B_{MSY}) proxy if the survey index was thought to be reflective of a stock's population trend (DFO 2012).

To explore this possibility further for secondary fish stocks, a framework assessment science advisory meeting was held December, 16-17, 2014, at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia. The overall objective of the meeting was to peer-review a proposed method for estimating biological reference points for a variety of secondary groundfish stocks in DFO Maritimes using summer and winter RV survey biomass indices. The meeting Chair-person, Mr. Kristian Curran, first introduced himself, followed by an introduction of meeting participants (Appendix 1). The Chair thanked meeting participants for attending the DFO Science Advisory Process. The Chair noted that this was a science peer-review meeting in which a science advisory report may be completed pending acceptance of the method being proposed. The Chair provided a brief overview of the Canadian Science Advisory Secretariat (CSAS) science advisory process and invited participants to review the meeting Terms of Reference (Appendix 2) and Agenda (Appendix 3). No revisions or additions were made to the Terms of Reference or Agenda. To guide discussion, a Working Paper was provided to meeting participants on November 28, 2014, in advance of the meeting date. This Proceeding constitutes a record of the meeting's discussion and conclusions.

PRESENTATION AND DISCUSSION

Rapporteur: Kristian Curran

THE PROXY APPROACH

Presenters: Tara McIntyre and Don Clark

The lead authors of the Working Paper, Tara McIntyre and Don Clark, briefly reviewed the DFO Maritimes policy on science in support of secondary stocks. They clarified that primary stocks typically receive full science assessment, while secondary stocks do not receive similar support given their lower priority status. The authors further noted that RV Survey trends provide a monitoring tool for various fish stocks in the region, and that DFO Maritimes aims to develop more robust metrics for secondary stocks consistent with the PA Policy. Based on RV Survey data, the authors proposed a "Proxy Approach" for estimating reference points for secondary stocks: the geometric mean of the stratified total biomass from the RV Survey (summer or winter, dependent on the stock) as a proxy for B_{MSY} for a chosen time period.

Biological reference points were subsequently calculated where 40% of the proxy B_{MSY} was proposed as the LRP and 80% of the proxy B_{MSY} was proposed as the USR. The three-year running median was then used to examine the long term trend in biomass against the reference points, as it dampens the effect of outliers caused by individual survey years of high biomass resultant of one or two large catches. Confidence intervals were calculated following the bootstrap with replacement method proposed by Smith (1997). For some of the stocks in this process, a truncated period of time was identified from the time series of stratified total biomass as the reference period when calculating B_{MSY}. The decision to use a truncated period was based on an assumption that a reduction in biomass observed in the recent past may not have been caused by a shift in its productivity regime, and that there is potential in the future for the stock to return to the biomass observed in the reference period.

Discussion

The authors presented results of the Proxy Approach on a species-by-species basis. A meeting participant requested clarification on how the three year running median was calculated. The author indicated that a number of end-point rules existed, further noting that the only data point that matters is the last one – the median of the past three values. There was further discussion on methods that take the slope of survey weight to project forward, although it was agreed it is difficult to project a meaningful trend when there is much inter-annual variability in the data. In contrast, a meeting participant suggested that the last value only has importance when you have a Harvest Control Rule (HCR) or other decision rules in place; for example, 4X White Hake has an HCR with a built in response to account for inter-annual variability (i.e. conservative management measure). For species such as 4X White Hake, which exhibit high levels of inter-annual variability in the data, applying a conservative HCR allows for more predictable exploitation over the long-term that is not subject to fluctuation in the last data point in the survey time series. It was agreed by meeting participants that when calculating reference points and developing HCRs it is important to know the origins, limitations, and history of the data.

The authors indicated that the proposed analytical approach is conservative in nature, although the confidence intervals often span both the upper and lower reference points. A meeting participant noted that confidence across years is more nuance, and that the proposed approach makes a lot of assumptions about constancy that may not be true for all secondary species being evaluated (e.g. survey catch may change from year-to year, although stock abundance may not have). It was noted, however, that confidence intervals provide important information

that should be included in the analysis, although one should be careful how such intervals are interpreted. As further evaluation of the proposed approach, a meeting participant inquired if it had been applied to more well-known stocks to see how robust the approach may be. The author indicated that this had been looked at briefly, but not in any significant detail. The meeting participant replied that one may get differences when comparing reference points estimated from the Proxy Approach compared to those estimated from other analytical approaches used for primary species (e.g. VPA), particularly when analytically-based reference points do not fall within the biomass time series for the given species.

The meeting discussion then turned to suitability of applying the proposed approach to secondary species that have little information. For instance, various approaches have been used to evaluate reference points for pollock that reach similar conclusions, although it is known for pollock that the RV Survey has many limitations in its design and gear (the discussion briefly focused on conversion factors applied to secondary stocks when DFO changed its survey vessels/gear). Similarly, for species believed to be over-depleted, it may be difficult to identify which portion of the time series is most suitable to estimate reference points; thus, the Proxy Approach may need to better account for a stock's history, in order to better understand the underlying context of the estimated reference points. Further, the geographic range of the RV Survey being limited to Canadian waters may hinder the ability to distinguish between species movement from actual increases/decreases in biomass (particularly for transboundary stocks).

Regardless of limitations in the Proxy Approach, some meeting participants agreed that deriving reference points for many of the secondary species in question is of great importance, as there are some urgent management needs for many of the species (especially for skates). Additional research in this regard was encouraged by all meeting participants.

EVALUATING UNCERTAINTY

Presenter: Stephen Smith

Stephen Smith examined the use of additional stock information to inform the Proxy Approach, as well as to evaluate uncertainty within the context of the Proxy Approach (Appendix 4). As an example, the haddock biomass time series appeared to be made up of four or five events, with recent productivity being lower than the whole series or during the fishery's period. The presenter noted that all reference periods exhibited a trend with respect to B_{MSY}, although recent annual changes exhibited more decreases than increases – the presenter questioned if this could be a fishery effect. Based on additional analytics, the presenter concluded that a two-phased model for survey data post-1991 might be applicable in evaluating the haddock stock. Mr. Smith's presentation demonstrated the importance of drawing upon additional information when interpreting a fish stock, as well as the potential need for additional analytics to evaluate uncertainty when applying the Proxy Approach.

Discussion

It was agreed by meeting participants that the intent of biological reference points is to say something about a stock's productivity – in this case survey biomass is used to set proxies for overall biomass. It was further agreed that the Proxy Approach that has been presented has been applied to other fish stocks, although depending on the individual fish stock there may be additional information (e.g. historical context of fishery) that is not being used to inform reference points or is not available (e.g. bycatch species not consistently monitored) to inform reference points. Given uncertainty in applying the proposed Proxy Approach to all secondary species, it is recommended that further research be undertaken to explore the secondary stocks that have been presented, including an evaluation of uncertainty where it may apply.

CONCLUSIONS

THE PROXY APPROACH

A "Proxy Approach" for estimating reference points for secondary stocks was proposed: the geometric mean of the stratified total biomass from the RV Survey (summer or winter, dependent on the stock) as a proxy for B_{MSY} for a chosen time period. Biological reference points were subsequently calculated where 40% of the proxy B_{MSY} was proposed as the LRP and 80% of the proxy B_{MSY} was proposed as the USR. The three-year running median was then used to examine the long term trend in biomass against the reference points, as it dampens the effect of outliers caused by individual survey years of high biomass resultant of one or two large catches. Confidence intervals were calculated following the bootstrap with replacement method proposed by Smith (1997). For some of the stocks that were analyzed, a truncated time period was identified from the time series of stratified total biomass as the reference period when calculating B_{MSY}. The decision to use a truncated time period for some stocks was based on an assumption that a reduction in biomass observed in recent past may not have been caused by a shift in the stock's productivity regime and that there is potential in the future for the stock to return to the biomass observed in the reference period.

EVALUATING UNCERTAINTY

Guidance for evaluating uncertainty associated with the Proxy Approach is:

1. Evaluate if survey indices reflect a fishery's impact on the stock;
2. Evaluate the impact of choice of period in the time series; and
3. Evaluate additional information you have to inform the impact of the Proxy Approach.

DOCUMENTATION OF MEETING FINDINGS

It was agreed by meeting participants that the final Research Document would include all species presented and discussed at the meeting, and that the document would also include the analysis presented by Stephen Smith for further guidance on dealing with a stock's history, as well as evaluating uncertainty, when applying the Proxy Approach. Given that many species discussed at the meeting required further analysis, it was agreed that a Science Advisory Report would not be completed and published as part of the meeting products. As such, products of the framework assessment meeting are only to include a Research Document and Proceedings.

REFERENCES CITED

DFO, 2006. A Harvest Strategy Compliant with the Precautionary Approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023.

DFO. 2012. Reference Points Consistent with the Precautionary Approach for a Variety of Stocks in the Maritimes Region. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/035.

Smith, S.J. 1997. Bootstrap Confidence Limits for Groundfish Trawl Survey Estimates of Mean Abundance. Can. J. Fish. Aquat. Sci. 54: 616-630.

APPENDICES

APPENDIX 1: LIST OF MEETING PARTICIPANTS

Name	Affiliation
Christensen, Cameron*	Dalhousie University / Biology
Clark, Don	DFO Maritimes / Population Ecology Division (BIO)
Claytor, Ross	DFO Maritimes / Population Ecology Division (BIO)
Coffen-Smout, Scott*	DFO Maritimes / Oceans and Coastal Management
Comeau, Peter	DFO Maritimes / Population Ecology Division (BIO)
Cook, Adam	DFO Maritimes / Population Ecology Division (BIO)
Curran, Kristian	DFO Maritimes / Centre for Science Advice
d'Entremont, Alain	Scotia Harvest Seafoods Inc. / O'Neil Fisheries Ltd.
Francis, Cory*	The Confederacy of Mainland Mi'kmaq (CMM)
Fuller, Susanna*	Ecology Action Centre (EAC)
Grant, Catharine*	Ecology Action Centre (EAC)
Hurley, Peter*	DFO Maritimes / Population Ecology Division (BIO)
MacDonald, Carl	DFO Maritimes / Resource Management
McIntyre, Tara	DFO Maritimes / Population Ecology Division (BIO)
Perrier, Erika	Mi'kmaw Conservation Group
Schleit, Katie*	Ecology Action Centre (EAC)
Smith, Stephen	DFO Maritimes / Population Ecology Division (BIO)
Vascotto, Kris	NS Dept. Fisheries and Aquaculture / Marine
Worm, Boris*	Dalhousie University / Biology

*Participants did not attend both days of the meeting

APPENDIX 2: MEETING TERMS OF REFERENCE

Terms of Reference

Framework for Use of Research Vessel Survey Data to Assess Secondary Groundfish Stocks in the Maritimes Region

Regional Peer Review – Maritimes Region

December 16-17, 2014
Dartmouth, NS

Chairperson: Kristian Curran

Context

In Fisheries and Oceans Canada's (DFO's) Maritimes Region, a protocol describing priority stocks for fishery assessment and management departmental resource allocation has been produced with an overall objective of better alignment between the science provided and the resulting management strategy. This protocol separates stocks into Primary and Secondary categories that define the difference in the DFO response to requests for advice and allocation of departmental human and financial resources. Secondary groundfish stocks include groundfish stocks being caught by the groundfish fisheries, or caught as bycatch in other fisheries, where the value and volume of landings of that stock are relatively small, and where the stock has not otherwise been identified as a priority by the DFO Maritimes Region (e.g., because of an important ecological role played by the stock or because the stock has important cultural uses). Formal stock assessments are not conducted by DFO Science for secondary stocks in the Maritimes Region. However, trends in Research Vessel survey indices are reported annually for some secondary groundfish stocks. Research vessel survey information has been used to set reference points for some groundfish stocks in the Maritimes Region, e.g., Eastern Pollock (DFO 2012).

Objectives

The objective of this meeting is to develop a methodology for using research vessel survey data to assess secondary groundfish stocks in the Maritimes Region, and, more specifically, to provide advice on an appropriate method for calculating reference points for the following secondary groundfish stocks:

- White Hake (4X5Yb, 4VW)
- Haddock (4VW)
- Monkfish (4X5Yb)
- Thorny Skate (5Z, 4X5Yb)
- Little Skate (5Z, 4X5Yb)
- Barndoor Skate (5Z, 4X5Yb)
- Smooth Skate (5Z, 4X5Yb)
- Longhorn Sculpin (5Z, 4X5Yb)

Expected Publications

- CSAS Science Advisory Report
- CSAS Proceedings
- CSAS Research Document(s)

Participation

- DFO Science, Resource Management, and Ecosystem Management branches
- Provinces of Nova Scotia and New Brunswick
- Academics
- Aboriginal communities/organizations
- Fishing Industry
- Other invited experts

References

DFO. 2012. Reference points consistent with the precautionary approach for a variety of stocks in the Maritimes Region. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/035.

APPENDIX 3: MEETING AGENDA

Framework for Use of Research Vessel Survey Data to Assess Secondary Groundfish Stocks in the Maritimes Region

Maritimes Regional Peer Review

Needler Boardroom
Bedford Institute of Oceanography
1 Challenger Drive, Dartmouth, NS

December 16-17, 2014

Chair: Kristian Curran

DRAFT AGENDA

December 16, 2014 – Tuesday

1:00 – 1:15	Introduction (Chair)
1:15 – 2:00	Presentation of method for calculating reference points for secondary species
2:00 – 2:45	Discussion
2:45 – 3:00	*Break*
3:00 – 3:45	Discussion continued
3:45 – 4:00	Wrap-up Day 1

December 17, 2014 – Wednesday

9:00 – 9:15	Review of Day 1
9:15 – 10:30	Continue discussion of methodologies
10:30 – 10:45	*Break*
10:45 – 12:00	Review of SAR
12:00 – 1:00	Lunch
1:00 – 2:45	Continue review of SAR
2:45 – 3:00	Wrap-up of meeting

APPENDIX 4: EVALUATING UNCERTAINTY (STEPHEN SMITH)

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SECONDARY SPECIES RAP

Stephen Smith

DECEMBER 15/16 2014

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Precautionary Approach

Limit reference point (LRP):

- **Avoid recruitment overfishing**
- **40% B_{msy}**

Upper stock reference point (USR):

- *Allow time for management decisions to be made to avoid LRP Can be a target...*
- 80% B_{msy}

Removal reference point:

- Part of harvest control rule
- Management action through changing fishing mortality

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Precautionary Approach: B_{MSY}

- In some jurisdictions is a target (e.g., US, ICES)
- Also a reference point for MSC stocks
- Productivity based, a function of:
    - Growth
    - Natural mortality
    - Recruitment

DFO PA policy allows for estimating B_{MSY} using mean of a stock indicator over productive period

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Precautionary Approach: Uncertainty

DFO POLICY ACKNOWLEDGES THAT UNCERTAINTY WITH RESPECT TO AVAILABLE INFORMATION AND KNOWLEDGE NEED TO BE CONSIDERED

- *Designation of primary/secondary species reflects work priorities but…*
- Also reflects amount of information and uncertainty
- *Table of LRPs and USRs does not necessarily convey degree of uncertainty*
- Stocks in Table 1 represent a range of knowledge, data and uncertainty
- *Some other jurisdictions (e.g., US, Australia) have developed a tier system*

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Precautionary Approach: U.S. Tier System

- Data rich
  - Tier 1: Reliable point estimates of B and B_{msy} and reliable pdf of F_{msy}
  - Tier 2: Reliable point estimates of B, B_{msy}, F_{msy}, F35%, and F40%
  - Tier 3: Reliable point estimates of B, B40%, F35%, and F40%
  - Tier 4: Reliable point estimates of B, F35%, and F40%
- Data poor
  - Tier 5: Reliable point estimates of B and natural mortality rate M
  - Tier 6: Reliable catch history from 1978–1995
- Uncertainty taken into account in advice
- Different calculations for over-fishing level and allowable biological catch
- Objective is to provide more conservative advice as uncertainty increases

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Secondary Species

All reference points based on survey data even though there may be other information available (e.g., 4VW haddock)

- No fishery data, catch series for context
- Survey indices use all strata in management area even though species may not occupy all strata
- Justification for productive period not obvious or necessarily consistent
- All survey indices are assumed to track the impact of the fishery on the population

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Survey Indices: Options

1 Track population dynamics: Impact of fishery:

A) Two-phase model (Trenkel, 2008)

$$B_t = g_{t-1} B_{t-1} + R_{t-1},$$

$$Log(g_t) = log(g_{t-1}) + \varepsilon_t,$$

$$\varepsilon_t \sim N(-0.5\sigma^2, \sigma^2)$$

B) CUSUM and SS_CUSUM model (Mesnil and Petitgas 2009, Pazhayamadom et al. 2013)

- **Quality control chart methodology**
- **Rule to pick up deviations from reference value in terms of standard deviation units.**

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Productive Period

1. **Stable period in terms of exploitation?**
2. **Highest productivity (transient?)**
3. **Why a geometric mean?**
4. **Median more insensitive to occasional large survey indices.**

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Uncertainty Measures

1) Behaviour during reference period:

- **Runs above and below Bmsy estimate**

2) Annual trend test:

- **Runs test applied to annual differences**

3) Direction of trend:

- **Sign test applied to annual differences**

4) Growth assumptions for Two-phase model:

- **Random annual growth vs. random walk**

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Example of 4VWX Haddock

4VW haddock: whole time series used:

1. Fishery until 1993, bycatch and closure after that
2. Assessment used q-corrected survey trends
3. Substantial growth changes noted after mid-1980s (Mohn and Simon 2004)
4. Possible habitat availability changes (Smith and Page 1994, Smith et al. 1994)
5. Recruitment available from survey

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Example of 4VWX Haddock: B_{MSY} Estimates

Years	Geometric mean	Median
1970–2013	49326	56081
1970–1992	47955	64498
1992–2013	50873	47603

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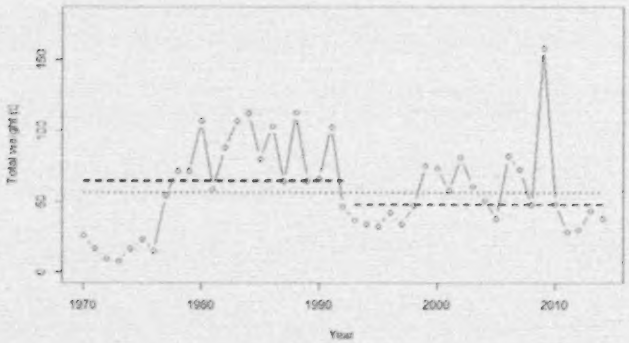
Example of 4VWX Haddock



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Example of 4VWX Haddock: Uncertainty Measures

Years	Above and B	Annual Trend Run test	Direction Sign test	Randomness
1970–2013	Trend (p<0.001)	Random (p=0.109)	Decreasing (p=0.047)	Random walk (p=0.026)
1970–1992	Trend (p=0.008)	Random (p=0.199)	No trend (p=0.17)	Random (p=0.10)
1993–2013	Trend (p=0.001)	Random (p=0.165)	Decreasing (p=0.005)	Random walk (p=0.02)

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Example of 4VWX Haddock: Uncertainty Measures

- **Haddock time series appears to be made up of four or five events.**
- Recent productivity lower than whole series or during fishery period
- All reference periods exhibit trend with respect to B^{MSY}
- Recent annual changes exhibit more decreases than increases — a fishery effect?
- Two-phase model for survey data post 1991 might be applicable

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Further Comments

White Hake reference period (1970–1990)

- **No TAC until 1996**
- **Landings peaked in 1987 (survey in 1985)**
- **Bycatch fishery starting in 1999 (quota caps for fixed and mobile gear)**
- **Stock complex 4VWX/5Y. Bundy and Simon (2005) report <10% catch in 4VW after 2002**
- **No evidence for trends after 1991 (runs test and sign test). Random walk test indicates memory after 1991**

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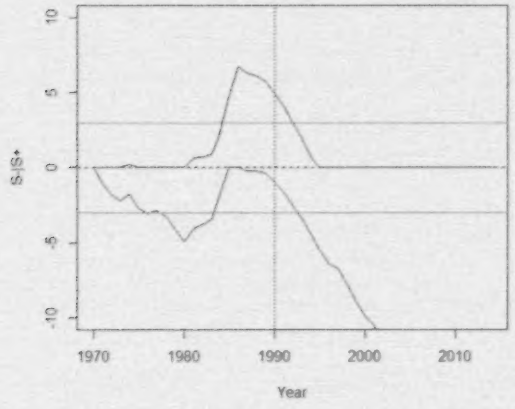
White Hake CUMSUM Plot



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Main Points: Secondary Species

- **Lower priority for assessment work and unlikely to be reviewed anytime soon**
- **Ignores fishery information**
- **All species here are bycatch of other target species**
- **Management action -> reduce fishery mortality or use move away protocols for target species**
- **Assume that survey tracks population trends without any qualification/evaluation**
- **In turn would expect to see impact of management action in survey index**